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REPORT OF THE RESULTS

OBTAINED ON

EVAN HALL,
BELLE ALLIANCE,

SOUVENIR,
NEW HOPE,

BELLE TERRE,
AND PALO ALTO

PLANTATIONS.

BY

PROF. LEZIN A. BECNEL,

CHEMIST.

NEW ORLEANS:
L. GRAHAM & SON, PRINTERS, 99, 101, 103 GRAVIER STREET.
1889.

ERRATA.

Page 20, 1st column, in table headed "PLANT CANE," read

Palo Alto 24 45

instead of

Palo Alto 14.45

Page 20, 2d column, top, in table headed "JUICE EXTRACTED," the sub-heads should read "*Gallons*" "*Pounds*" instead of "*Barrels*" "*Poands.*"

Page 21, 1st column, in table headed "RESULTS PER TON AND PER ACRE," the sub-headings should read "*Ton*" "*Acre*" instead of "*Tons*" "*Acres.*"

Same table, in heading, read "COMMERCIAL MASSE CUITE" instead of "COMMERCIAL MASSE C'TES."

Same table, in column headed "COMMERCIAL MASSE C'TES" Palo Alto should be credited with 5,080 instead of 5,08.

Next succeeding table read

Belle Terre 23 00
Palo Alto 21.00

instead of

Belle Terre 23
Palo Alto 21

Next succeeding table read

Belle Alliance 15 60

instead of

Belle Alliance 15.6

Page 21, 1st column, bottom, in table of losses in manufacture, read

On Evan Hall 16.40
On Palo Alto 5.50

instead of

On Evan Hall 16.4
On Palo Alto 5 5

REPORT OF THE RESULTS OBTAINED

ON EVAN HALL, BELLE ALLIANCE, SOUVENIR, NEW HOPE, BELLE TERRE, AND PALO ALTO PLANTATIONS.

By PROF. LEZIN BECNEL, Chemist.

Evan Hall Plantation,
McCall P. O., La., June 16, 1890.

To the McCall Bros. Planting and Manufacturing Co., Limited, Messrs. E. & J. Koch, Leon Godchaux, Gen. W. P. Miles, Messrs. B. Lemann & Bro., and Lemann & Lum: Gentlemen--It affords me great pleasure to hand you herewith my final report on the crop of 1889. Said report includes both field and factory results, and has been made as complete as the data at my disposal have permitted. I also desire to sincerely thank you for the facilities which you have given me to carry out this work.

To my assistants, Messrs. Chas. R. Gaines, C. A. Hartwell, Richard Short, C. S. McFarland, Walter B. Wiley, and, last but not least, Mr. Clinton Townsend, I desire to express my thanks for the manner in which they have acquitted themselves of the tasks allotted to them. Yours very respectfully,

Lezin A. Becnel,
Chemist.

Crop of 1889, Evan Hall Plantation.

PART I.

FIELD RESULTS.

It will be remembered that the cultivating season of 1889 was an unusually dry one, and that very grave apprehensions were accordingly entertained as to the general result. Contrary to general expectations the result in tonnage per acre exceeded the most sanguine estimates made just before grinding.

The data relating to the yield of each cut separately show very interesting differences in the results obtained on the lands worked on the "gang system" for account of the plantation proper and those obtained by the different "tenants" on other parts of the field.

It is very unfortunate that our statistical system has not as yet reached that degree of excellence which would permit of the classification of the different soils according to their natural fertility and chemical properties. Proper analyses of soils and fertilizers would, in time, be the best guide as to what special fertilizers should be used and in what manner they should be applied to the different cuts of sandy, mixed, and stiff land.

While fully appreciating the disturbing elements of different climatic conditions, relative excellence of stand, condition of seed at the time of planting, etc., we nevertheless believe that in time not only the saccharine content of the cane could be improved, but a greater uniformity of results be established between the different cuts, which, to all appearances, are of the same general character of soil. Both our data and experience, are, however, too meagre to admit of even an approach to this.

Believing that even a little information is better than none, we will try to show where the differences occur, and which fertilizers appear to have given the best results during the past season. To do this, the soils will be divided into two main classes, viz.: "Old lands," or those in cultivation before the war and for a longer period than ten years; and "new lands," those in cultivation since the commencement of the present decade. In turn, these will be subdivided into sandy, mixed, and stiff lands. The terms "sandy," and "stiff," require no explanation, for the characteristics of these soils are well known to every agriculturist. When applied to soils the term "mixed" may require some explanation. Besides the lands usually called chocolate loams the term "mixed" will also include those cuts which are sandy on one end and gradually slope to a stiff bottom at the other end.

In the individual comparison of the results of the plantation and those of each tenant, the kind of fertilizer and the rate per acre at which it was used will be taken into consideration. After the individual comparisons the results will be compared from the standpoint of soil and fertilizer used irrespective of the cultivator. By this means it is hoped to at least get an indication of the relative values and results of each fertilizer used.

Before going on to the discussion of the above results it is well to note the composition and character of the fertilizers used on the past crop. These were four in number, viz.: First, a mixture of 50 per cent dissolved bone or acid phosphate, 40 per cent cotton seed meal, and 10 per cent land plaster; second, Stern's high grade sugar fertilizer; third, soluble Pacific guano; and fourth, Armour's hog tankage.

Having explained the plan of comparison which is to be pursued, and stated which fertilizers were used, we will commence with the

INDIVIDUAL RESULTS.

In the following table will be found the results attained with plant cane on old sandy lands:

Cultivator.	*Fertilizer used, and rate per acre.*	*Tonnage per acre.*
A	Hog Tankage, 600 lbs. per acre	18.36
B	Hog Tankage, 600 lbs. lbs acre	16.98
C	High Grade, 600 lbs. per acre	22.40
D	High Grade, 600 lbs. per acre	22.00

A comparison of A's and B's results shows that under the same apparent conditions, A gets an excess of 1.38 tons per acre, meaning that his result is 8.13 per cent better than B's.

In C's and D's case the difference is only .4 tons, but, although small, it should not be passed unnoticed, since it represents an excess of 1.8 per cent in C's favor.

Next in order, are the results with first year's rattoons on old sandy lands, which are as follows:

Cultivator	*Fertilizer used, and rate per acre.*	*Tonnage per acre.*
Plantation	High Grade, 900 lbs. per acre	17.77
C	High Grade, 600 lbs. per acre	19.60
D	Hog Tankage, 600 lbs. per acre	23.16
B	Hog Tankage, 600 lbs. per acre	24.61
A	Hog Tankage, 600 lbs. per acre	22.50

The plantation results as compared with those of a tenant are worthy of observation. It will be seen that the plantation used 50 per cent more fertilizer than did C, with whose results it is to be compared.

All things being equal and notwithstanding a probable lack of soil fertility, one would suppose that with such a large excess of high grade the plantation should at least have gotten as much cane from one acre of land as did the tenant, C. The contrary is however the case. C produced 2.17 tons more, or an excess of 12.12 per cent. With tankage as fertilizer B's, D's, and A's results can be compared.

By referring to the above table it will be seen that A's results are the poorest. Compared with these, D is shown to have produced an excess of .66 tons, which give him a 2.93 per cent superiority of result. In the same way B is shown to have produced an excess of 2.11 tons, or a 9.38 per cent superiority of result over A, and 1.45 tons, or a 6.26 per cent rate of excess, over D.

Want of sufficient data compels the closing of these comparisons of individual results with the yields of first year's stubble on old mixed lands. These are as follows:

Cultivator.	*Fertilizer used, and rate per acre.*	*Tonnage per acre.*
Plantation	High Grade, 900 lbs. per acre	19.10
E	High Grade, 600 lbs. per acre	25.10

This is another instance in which a tenant obtains a better result than the plantation. E with one-third less fertilizer makes 6 tons more cane per acre, giving him a 31.34 per cent superiority of result.

Before dismissing the subject of the comparison of results obtained on soils of same apparent general character, it is well to bear in mind that these same differences have a definite financial meaning. The smallest difference which has been noticed was one of 0.40 tons per acre. Although apparently insignificant, it nevertheless represents an additional $1.40 per acre to the cultivator, when his cane is worth $3.50 per ton delivered. On the other hand, the largest difference noted was 6 tons per acre, representing a net profit of $21 more for the cultivator. These differences are as important from the manufacturing standpoint as they are from the agricultural. According to the average result per ton during the past season, 6 tons of cane represent 870 pounds of additional sugar per acre, which along with the proportional molasses would swell both the final output of the factory and the commercial value of a crop.

RESULTS OF FERTILIZATION.

As above, the results obtained on like soils will be compared, but without regard to the special cultivator having charge of same. The average tonnage per acre, of either plant or stubble, for a given quality of soil and fertilizer, will be compared with that produced by the use of some other fertilizer, without, however, neglecting to take into consideration the rate in pounds at which they were used.

On sandy land plant cane, the results were as follows:

Six hundred pounds mixture per acre produced 21.84 tons.

Six hundred pounds soluble Pacific guano per acre produced 21.87 tons.

Six hundred pounds tankage per acre produced 17.67 tons.

Six hundred pounds high grade per acre produced 22.20 tons.

Six hundred pounds high grade and mixture per acre produced 20.25 tons.

Remembering that definite conclusions can by no means be derived from the limited data at our disposal, the following remarks are to be interpreted simply as an approximation of the true results:

With tankage as a basis of comparison, the above table shows the apparent superiority of the other fertilizers to have been as follows:

High grade and mixture, 2.58 tons, excess equal to 14.66 per cent.

Mixture alone, 4.17 tons, excess equal to 23.60 per cent.

Soluble Pacific guano, 4.20 tons, excess equal to 23.77 per cent.

High grade alone, 4.53 tons, excess equal to 24.51 per cent.

On the basis of the results obtained with the double mixture of high grade and "Standard mixture," the excesses of results are as per the following statement, viz.:

Mixture alone, 1.59 tons, equal to 7.85 per cent.

Soluble Pacific guano, 1.62 tons, equal to 8 per cent.

High grade alone, 1.95 tons, equal to 9.63 per cent.

It will be noticed that the results with mixture alone and with soluble Pacific guano were practically the same, and that high grade alone only exceeds these by 1.51 per cent on the basis of soluble Pacific guano and 1.65 on that of mixture.

On sandy land rattoons the results were:

With 750 pounds high grade per acre, 18.68 tons.

With 600 pounds tankage per acre, 23.43 tons.

With 900 pounds meal and Pacific guano per acre, 21.95 tons.

Showing that the best results were obtained with tankage. With these as a standard it will be seen that notwithstanding a 50 per cent increase of fertilizer the results with meal and soluble Pacific guano show a 6.31 per cent inferiority. If compared with high grade, an excess result of 25.43 per cent is shown for 25 per cent less fertilizer, indicating that tankage produced 50.43 per cent more cane under the same apparent conditions. In the case of meal and Pacific guano, as compared to high grade,

increased quantities produced increased tonnage. Excess of tonnage, however, is not found to be in proportion to increased quantity of fertilizer used, 20 per cent more meal and Pacific guano produced but 17.51 per cent more tonnage than high grade.

Next in order come the results on mixed land plant cane. These were:

With 600 pounds soluble Pacific guano, 21.70 tons per acre.

With 600 pounds tankage, 20.91 tons per acre.

With 600 pounds mixture, 20.34 tons per acre.

Showing that for equal quantities of fertilizer, tankage is 2.80 per cent better than mixture, whilst soluble Pacific guano shows a superiority of 3.78 per cent over tankage and 6.72 per cent over mixture.

On mixed land, first year's stubble, we have:

With 750 pounds high grade, 22.11 tons per acre.

With 600 pounds tankage, 21.16 tons per acre.

Here again will be noticed that an excess of fertilizer did not produce a correspondingly large increase of result. In this instance, 25 per cent more high grade only produced a 4.49 per cent increased result over tankage. Other things being equal and an increased quantity of fertilizer producing a correspondingly increased result, the above is to be interpreted as showing that the results with high grade are about 21.51 per cent inferior to those with tankage.

On stiff land plant cane the results were:

With 600 pounds mixture and soluble Pacific guano, 16.41 tons per acre.

With 600 pounds high grade, 21.25 tons per acre.

Showing that for equal quantities of fertilizer high grade produced 29.43 per cent more cane than did the double mixture of soluble Pacific guano and mixture.

In the foregoing pages we have pointed out many surprising differences which are inexplicable by our present crude statistical systems. On these more light could probably be thrown by a more accurate soil classification than simply the sandy, the mixed, and the stiff.

Past experience having taught us that certain cuts produce tonnage more readily than others, the fertilization is carried on with some little attempt at system. Bearing in mind these differences of fertility, either the more highly nitrogenized or larger quantities of manure are put on those lands which appear to produce tonnage only with difficulty, and either the more highly phosphatized or smaller quantities of manure are put on those lands which have a natural tendency to produce tonnage.

Whilst excellent so far as it goes, this method could no doubt be greatly improved by the addition of proper soil analyses.

Any system tending to produce a greater uniformity of result is most highly desirable, as will be shown by the following facts and figures:

Of the 584 acres of plant cane ground during the present season, 66.79 per cent or 390 acres produced less than 23 tons and only gave an average of 20 tons per acre. The remaining 194 acres producing 23 and more tons per acre gave a general average of 24,50 tons, which is only $\frac{5}{10}$ of a ton below the usual average for plant cane on this place. If it be assumed that this average of 24.50 tons is practically up to the standard, the remaining 390 acres show a shortage of 1,755 tons, or an average of 4.50 tons per acre.

To the cultivator this represents $6,142.50 when cane is worth $3,50 per ton delivered.

According to actual sugar-house results this cane would have yielded some 254,500 pounds of sugar and 217 barrels of molasses

With regard to the stubble crop, all that can be said is that its results are almost without precedent. For the past 13 years the average per acre was only 20 tons, against 22.80 for 1889. This large tonnage was entirely due to the unusually good stand of cane on the land.

Compared with the results of 1888, the general field result is as follows: According to the general average tonnage per acre the plant cane crop is found to be 19.42 per cent short. The stubble on the other hand is found to show a 16.62 per cent excess. Hence the conclusion that the general result for 1889 was 2.80 per cent short. From the foregoing it follows that too much stress can not be put on the advisability of an early start in the matter of the improvement of the present agricultural statistics.

Aided by the chemical analysis of mill juices and other sugar-house products, the adoption of improved statistical systems has undoubtedly reduced the losses of manufacture.

Although possibly more difficult of attainment, there is no doubt that improved methods can be made to have the same beneficial effects on the agricultural results which they are known to have had on those of manufacture.

PART II.

SUGAR-HOUSE RESULTS.

Having succeeded in giving to our weekly data almost the same degree of accuracy which we claim for that relating to the entire season's work, we, in the following pages, will call attention to all points of superiority, (as well as to those of inferiority,) which our data point out, making thereon all remarks which may suggest themselves. Of the different subjects which make up the general sugar-house results the first one requiring attention is the

RUNNING TIME.

By counting each watch of six hours as one-quarter of a day, and only counting those watches during which the mills ran, whether it be during a part only or during the entire watch, the running time for each week or run is as per the following table:

Week ending October 20, or first run, 4.50 days.

Week ending October 27, or second run, 6.50 days.

Week ending November 3, or third run, 4.25 days.

Week ending November 10, or fourth run, 5.75 days.

Week ending November 17, or fifth run, 6.25 days.

Week ending November 24, or sixth run, 6 days.

Week ending December 1, or seventh run, 6 days.

Week ending December 8, or eighth run, 6 days.

Week ending December 15, or ninth run 3.75 days.

Total for the crop, 49 days.

Without accidents to the machinery, it is our belief that a stoppage of twelve hours every Sunday is all the time necessary to do the usual cleaning up of bagasse burner, boilers, etc. As was the case on the second run, it follows that the mill should run during twenty-six entire watches each week. The shortness of the first run was due first, to not starting the mill until Tuesday morning, October 15, and secondly, to the breaking of a crown wheel, which caused a delay of three entire watches. We understand that at Belle Alliance and on other plantations the mills are started with the very first loads of cane delivered under the shed. This is an excellent plan, and one which, in the case under discussion would have made the running time of the first run 5.50 days, instead of 4.50, and this, after making all necessary allowances for the replacement of the broken crown wheel.

On the third run, nine watches were lost, owing to the necessity of certain repairs to leaky vacuum pan coils. After making all necessary allowance for the above justifiable losses of time, it was found that on the second run only the mill ran during its full quota of time. As will be remembered, all other losses of time were the result of groundless fears of a block in the boiling end of the sugar house.

In the following table is given the lost time for each week in terms of the number of watches and per cent of the full allotment of time during which the mill should have run after making necessary allowances for repairs of machinery:

First run, four watches, equal to 16 per cent.

Second run, no watches, equal to no per cent.

Third run, no watches, equal to no per cent.

Fourth run, three watches, equal to 11.54 per cent.

Fifth run, one watch, equal to 3.85 per cent.

Sixth run, two watches, equal to 7.7 per cent.

Seventh run, two watches, equal to 7.7 per cent.

Eighth run, two watches, equal to 7.7 per cent.

There not having been enough cane to last through the week, no shortage is given for the ninth or last run. For the six runs, on which unnecessary losses of time occurred, the standard running time is represented by 152 watches, or thirty-eight full days. Of these, 6.58 per cent, or two and a half days, were lost by a disinclination to run the risk of having to stop the mill in the middle of a week in case a block did occur; and 2.63 per cent, or an entire day, by not starting the mill soon enough at the beginning of grinding.

Next in importance is the average number of hours during which the mill ran each day. Thirty to thirty-five minutes each day are, according to observations, all the time that is necessary to clean up and wash around the mill, juice strainer, sulphur machine, etc.

Disregarding all stops of less than five minutes duration, the running time of the mill was as follows:

On first run, $94\frac{00}{60}$ hours, equal to $22\frac{07}{60}$ hours per day.

On second run, $149\frac{00}{60}$ hours, equal to $22\frac{55}{60}$ hours per day.

On third run, $96\frac{30}{60}$ hours, equal to $22\frac{42}{60}$ hours per day.

On fourth run, $129\frac{30}{60}$ hours, equal to $22\frac{33}{60}$ hours per day.

On fifth run, $146\frac{00}{60}$ hours, equal to $23\frac{20}{60}$ hours per day.

On sixth run, $138\frac{15}{60}$ hours, equal to $23\frac{02}{60}$ hours per day.

On seventh run, $139\frac{15}{60}$ hours, equal to $23\frac{13}{60}$ hours per day.

On eighth run, $140\frac{30}{60}$ hours, equal to $23\frac{25}{60}$ hours per day.

On ninth run, $85\frac{00}{60}$ hours, equal to $22\frac{40}{60}$ hours per day.

Total crop, $1{,}118\frac{00}{60}$ hours, equal to $22\frac{49}{60}$ hours per day.

On the eighth run it will be seen the thirty-five minute limit was fully carried out. By taking the average hours of mill running of this week as a standard of comparison, the lost time for the other runs is:

On first run, $1\frac{18}{60}$ hours per day, equal to 5.55 per cent.

On second run, $1\frac{10}{60}$ hours per day, equal to 4.98 per cent.

On third run, $\frac{43}{60}$ hours per day, equal to 3.06 per cent.

On fourth run, $\frac{52}{60}$ hours per day, equal to 3.70 per cent.

On fifth run, $\frac{05}{60}$ hours per day, equal to .36 per cent.

On sixth run, $\frac{23}{60}$ hours per day, equal to 1.67 per cent.

On seventh day, $\frac{12}{60}$ hours per day, equal to .85 per cent.

On ninth run, $\frac{45}{60}$ hours per day, equal to 3.20 per cent.

General crop average, $\frac{36}{60}$ hours per day, equal to 2.56 per cent.

Part of this loss was caused by the breaking of the intermediate carrier slats, but 75 per cent of it is believed to have been due to avoidable causes. Of these the main one was running out of cane on the last night watch. This, in turn, was the result of overcrowding and consequent choking of the mill on the two night watches. Whatever be the number of tons of cane that are to be ground in the twenty-four hours, it is of the greatest importance that the feed be so regulated as to grind one-fourth the quantity on each watch. During the past season, and judging from the thickness of the feed, only from two-fifths to one-third of the cane was ground during the two day watches, the remaining three-fifths to two-thirds being crowded on the two night watches. This crowding of cane has many disadvantages, and offers no compensating advantages. Attention has already been called to some of these disadvantages, but nothing has as yet been said of the effect that irregular feeds have on the percentage of juice extracted from the cane. Another and not to be overlooked disadvantage of irregular feeds is the danger of breakage in either the mills or the gearing when these are subjected to the sudden strains caused by over thicknesses of feed.

According to the foregoing tables it has been seen that during the past season the mill ran during 1,118 hours. Of these 1.92 per cent, or nearly 21½ hours, were lost by avoidable causes. With a very full allowance for contingencies these 21½ hours represent three-fourths of a day of running time. If to this, the 3½ lost days, already spoken of, be added, it will be seen that in running time alone 4¼ days were unnecessarily lost during the season,

In the future a great deal of attention should be given to this question of running time. Although unimportant for one day, or even on a week's run, it nevertheless counts up; and, at the end of the season, it is found that besides the want of compensating results, the expenses of manufacture have been swelled by the proportion due to the number of days lost.

MILLING.

In the following table will be found the main data relating to the crushing of cane:

Number of run.	No. of tons cane ground.	Gallons of water used for saturation.	Gallons of diluted mill juice made.	Gallons of normal mill juice made.	Pounds of normal mill juice made.
First	1930	23000	350000	327000	2893950
Second	3078	41000	562500	521500	4625700
Third	1941	62500	394500	332000	2947030
Fourth	2545	125000	586500	461500	4106520
Fifth	2035	160000	671000	511000	4518322
Sixth	2710	128500	596500	468000	4168290
Seventh	2918	121500	626500	505000	4489250
Eight	3060	138500	681000	542500	4817400
Ninth	1756	64000	371500	307500	2747228
Totals	22873	864000	4840000	3976000	35313887

The foregoing figures are given more for purposes of reference than for comparison. Without going into the details of proportions which will be derived therefrom, they show that with a little care the mills can be easily made to grind 3,000 tons per week. In support of this assertion attention is called to the fact that on the seventh and eighth runs, respectively, the mills only ran six days or twenty-four watches each week, and ground a total of 5,978 tons. This is an average of 498 tons per day, and demonstrates that even on six instead of six and a half day runs the mills can be made to average 125 tons on a watch. That this can be done without detriment to the usual percentage of extraction is evidenced by the fact that the percentage of extraction for these runs is 78.76 and 79.05 per cent respectively.

In order to more closely study the milling results, subjoined will be found a series of tables of proportionate results derived from the preceding table.

From the point of view of the time required to grind a given quantity of cane, the actual results for each run are as follows:

On first run, 20.532 tons per hour of mill running.

On second run, 20.568 tons per hour of mill running.

On third run, 20.114 tons per hour of mill running.

On fourth run, 19.652 tons per hour of mill running.

On fifth run, 20.103 tons per hour of mill running.

On sixth run, 19.602 tons per hour of mill running.

On seventh run, 20.970 tons per hour of mill running.

On eighth run, 21.068 tons per hour of mill running.

On ninth run, 20.659 tons per hour of mill running.

Crop average, 20.460 tons per hour of mill running.

According to these figures the best results were obtained on the eighth run. Taking these as a basis of comparison the shortages for each of the other runs are:

First run, shortage of .536 tons per hour equals 2.55 per cent.

Second run, shortage of .500 tons per hour equals 2.37 per cent.

Third run, shortage of .954 tons per hour equals 4.53 per cent.

Fourth run, shortage of 1.416 tons per hour equals 6.72 per cent.

Fifth run, shortage of .965 tons per hour equals 4.58 per cent.

Sixth run, shortage of 1.466 tons per hour equals 6.96 per cent.

Seventh run, shortage of .098 tons per hour equals .47 per cent.

Ninth run, shortage of .409 tons per hour equals 1.94 per cent.

Crop average, shortage of .608 tons per hour equals 2.89 per cent.

The average of the cane ground per hour of mill running during the seventh and eighth runs is 21 tons. On this basis the 22,873 tons of cane for 1889 should have been ground in 1,089 hours, instead of 1,118. This is a difference of 39 hours, which, according to the $23\frac{26}{60}$ hours per day standard, represent a further and unnecessary loss of 1.67 days, or for greater simplicity, 1½ days. If to this the 4¼ days lost on the running time be added it follows that the crop of 1889 should have been taken off in 43¼ days.

After what has been said it follows that without detriment to either the safety of the machinery or the extraction the mill can be made to grind nearly 530 tons of cane per 24 hours.

It is of the greatest importance that proper remedies be applied to these losses of time. Besides the extra expense which they entail, it must be remembered that they protract the grinding season into the season of further loss by the deterioration of cane in windrow, and that attendant upon wet weather, muddy roads, etc. To conclude these remarks on the general subject of "milling" it is well to study the effects of saturation, hardness, and quantity of cane ground on the extraction of juice. For this purpose and from the general table given above the following proportional results are deduced:

RUNS.	Cane ground per square foot of roller surface per hour.	Tonnage per acre.	Saturation, per cent by weight of cane.	Per cent of juice extracted (normal juice).
First run	0.00227	21.19	4.96	74.97
Second run	0.00228	21.98	5.55	75.14
Third run	0.00222	25.54	13.46	75.95
Fourth run	0.00217	22.13	20.46	80.68
Fifth run	0.00222	21.42	22.71	76.86
Sixth run	0.00217	23.87	19.75	76.91
Seventh run	0.00232	21.30	17.25	76.93
Eighth run	0.00233	20.82	18.85	78.71
Ninth run	0.00228	20.90	15.18	78.22
Crop averages	0.00226	21.97	15.73	77.15

Owing to a lack of knowledge of the absolute quantity of woody fiber contained in the cane ground, the conclusions which will be derived from the following comparisons will not be as definite as we would like to see them.

It is to be presumed that the lower the tonnage the harder, and consequently the greater the percentage of woody fiber contained in the cane. According to this theory, under the same milling conditions the extraction is in direct proportion to the degree of softness of the cane. According to the above table, if the rate of saturation be taken into consideration, this theory seems to be justified.

For the same milling conditions it is found that the 2nd and 9th runs, the 3rd and 5th, and the 4th and 6th can be compared with each other. In the first case by grinding at the rate of .00228 tons per square foot of roller surface per hour, the extraction of the 9th run is found to be superior to that of the 2nd. This increase is in all probability due to the greater rate of saturation, for it will be noticed that the tonnage per acre of the 9th run is somewhat lower than that of the 2nd. In the comparison of the 3rd and 5th runs the same general conditions produce the same general result.

Contrary to expectation, compared with the 4th run, the 6th shows a decreased extraction with apparently softer cane. For this, two reasons can be given. First, the lower rate of saturation might account for part of the shortage, but the main cause is believed to be due to running the mill without saturation during several days. It was during this 6th run that owing to the sugar makers' belief that saturation produced impure juices, the mill was run without it. Although a greater rate of saturation was resorted to during the latter part of the week, it appears to have been inadequate to even compensate for the loss in extraction by want of saturation at the beginning of the run.

In the cases of the 1st and 2nd, and 7th and 8th runs, although the milling conditions were not absolutely the same, they were, however, sufficiently alike to justify a comparison of results. Compared with each other it will be noticed that on the 2nd run both an increased rate of saturation and a higher tonnage seem to have produced a better mill extraction. As has already been noticed in other instances, it will be seen that with a lower tonnage the extraction of the 8th run exceeds that of the 7th—the only apparent different condition being the increased rate of saturation.

During the manufacture of the crops of 1886 to 1888, inclusive, it will be remembered that little or no saturation was resorted to. The average tonnage per acre for these years was 23.88 tons. The average tons of cane ground per square foot of roller surface per hour was .00217, and the corresponding mill extraction was 75.56. All other things being equal, it is believed that a better extraction can be obtained by a thin feed than by a heavy one, and in consequence the extraction should be in inverse proportion to the feed carried. For want of a better standard of comparison, assuming the woody fiber to be in inverse proportion to the tonnage of cane, it follows that the extraction should be in direct proportion to the tonnage per acre.

Reasoning from the above, it appears that without saturation, the milling results of 1889 would have been as follows: Since per square foot of roller surface per hour, the feed carried in 1889 was 4.15 per cent heavier, the average extraction would have been 4.15 per cent less than it was during 1886, 1887, and 1888. This means that even with equally soft cane the extraction would probably have been 72.42 per cent, instead of 75.56 as already stated. If cane of 8 per cent less tonnage per acre is 8 per cent harder, this further reduces the probable extraction to 66.68 per cent. This would show a 15.22 per cent increased extraction due to saturation. To produce the actual 77.19 per cent extraction, 15.23 per cent of water was used on the 22,873 tons of cane ground. This would make it appear as if the water of saturation extracted 64.53 per cent of its weight in normal juice from the cane.

According to the actual sugar-house results this proportion of juice would represent eighteen pounds of commercial sugar to the ton of cane ground.

Our experience with the milling results of this place, however, leads us to suppose that even without saturation such cane as was ground during the past season would not have given less than a 70 per cent extraction.

If, on the basis of the foregoing estimate, it is assumed that cane which is 8 per cent lower in tonnage per acre is only 2 per cent harder, the probable extraction, without saturation, is 70.97 per cent, against 77.19 per cent with saturation.

According to these last figures the proportion of normal juice due to saturation is represented by 8.76 per cent of the weight of normal juice without saturation and 6.22 per cent on the weight of the cane. In dry sugar this juice represents eleven pounds per ton of cane according to the actual yields of the sugar-house.

With a view of trying to ascertain if saturation tended to impair the purity of the juice, a number of tests of the first mill juices and of the corresponding mixture of the first and second mill juices were made both with and without saturation. The average results of these are as follows:

COMPOSITION OF JUICE.	WITHOUT SATURATION.		WITH SATURAT'N.	
	First mill	*First and second mill*	*First mill*	*First and second mill*
Specific gravity	1.066	10.65	1.067	1.051
Degree Baumé	9.00	8.80	9.00	7.00
Per cent of total solids	16.16	15.91	16.25	12.63
Per cent of sucrose	12.80	12.35	12.82	9.80
Per cent of glucose	1.56	1.46	1.46	1.17
Per cent of solids not sugar	1.80	2.10	1.97	1.66
Ratio of glucose to sucrose	12.18	11.82	11.38	11.94
Ratio of solids not sugar to total solids	11.14	13.20	12.12	13.14
Purity coefficient	79.21	77.62	78.89	77.59

By comparing the above purity coefficients and ratios of glucose to sucrose and solids not sugar to total solids of the mixed juices with their corresponding first mill juices in the case without saturation is found: A 2 per cent decrease of purity coefficient, a 2.96 per cent decrease of ratio of glucose to sucrose, a 17.59 per cent increase of ratio of solids not sugar to total solids. With saturation the differences are: a 1.64 per cent decrease in purity coefficient, a 4.92 increase of ratio of glucose to sucrose and an 8.41 per cent increase of ratio of solids

not sugar to total solids. These differences tend to show that saturation is productive of purer juices than double milling alone, from the fact that fewer impurities are extracted from the cane. This is evidenced by the very much less increased ratio of solids not sugar to total solids, and is probably the result of the coagulation of certain of the albuminoids by the hot water used, and which remain imprisoned in the woody fiber of the cane when going through the second mill.

Without saturation the ratio existing between the glucose and the total solids is 9.65 per cent for the first mill and 9.18 per cent in the mixed juices. This is a decrease of 4.87 per cent. With saturation we have an 8.98 per cent ratio for the first mill and 9.26 per cent for the mixed juices, or an increase of 3.12 per cent.

When coupled with the increased glucose to sucrose ratio the last figure given shows that the use of hot water during saturation has caused an inversion of sucrose, which can be approximately estimated as follows: Without any inversion it is fair to assume that the ratio of glucose to total solids should be reduced in the same proportion that it was in the case of double milling without saturation. Accordingly, this ratio should have been 8.54 per cent, instead of 9.26 per cent. This would have made the percentage of glucose in the mixed juice of saturation 1.08 per cent, instead of 1.17 per cent, and accordingly shows an approximate inversion of a proportion of .086 parts of sucrose, or nearly .9 per cent of the sucrose which is accounted for by the analysis of said mixed juice of saturation.

According to the average mill extraction of the season, and the percentage of sucrose therein, 192.36 pounds of sucrose can be accounted for from each ton of cane ground. The sucrose inverted during the saturation is, according to the above figures, 1.73 pounds, showing that 194.09 pounds of sucrose were actually extracted from each ton of cane ground. Whatever may have been the exact cause of this inversion—heat alone, or combined with other causes, does not, for the time being, make much difference, for it is not of a sufficiently large proportion to condemn hot water saturation from a practical standpoint.

In terms of the commercial sugars the above 1.73 pounds of sucrose inverted represents less than two pounds per ton. It has been seen that notwithstanding this loss occasioned by inversion, saturation carried the extraction of eleven pounds more sugar per ton of cane than would have been extracted without it. Having no data on the subject of cold water saturation, nothing can be said as to the relative value of cold and hot water saturation, except that according to well-known physical principles, the writer doubts that in a given time cold water will mix as readily with the juices contained in the first mill bagasse as will hot water. However, circumstances so permitting, it is proposed to further investigate this question during the coming season.

In conclusion, we would strongly urge the continuance of saturation, (especially on hard cane,) and to the utmost limit of the evaporating capacity of the exhaust steam furnished by the different engines of the sugar house.

It is also desired to call special attention to the large percentage of trash brought to the sugar house. Dry leaves, it is true, do not materially affect the weight of a load of cane, but after having been passed through the mills they come out as wet as the accompanying bagasse. Since they contain no juice before crushing, the fact of their coming out wet is evidence that their moisture was produced at the expense of a certain quantity of juice which would otherwise go to swell the percentage of extraction, and ultimately the final output of the sugar house.

CLARIFICATION.

There are two distinct operations in the process of clarification, viz.: sulphuring and liming. In order to test the relative excellence of each of these operations the different juices were carefully tested. In the following table will be found the averages derived from these daily tests. That of the raw or mill juice is given in terms of the normal juice extracted from the cane, and those for sulphured and clarified juices in terms of the diluted juices:

	COMPOSITON OF—		
	Mill juice.....	*Sulphured juice.....*	*Clarified juice.....*
Specific gravity	1.065	1.053	1.057
Degree Baumé	8.8	7.5	7.9
Per cent total solids	15.89	13.24	14.08
Per cent water	84.11	86.76	85.1
Per cent sucrose	12.46	10.25	10.91
Per cent glucose	1.76	1.41	1.51
Per cent solids not sugar	1.67	1.58	1.66
Purity coefficient	78.48	77.42	77.49
Ratio of glucose to sucrose	14.13	13.75	13.84
Ratio of glucose to total solids	11.07	10.65	10.72
Ratio of solids not sug. to tot. solids	10.51	11.03	11.79

Owing to the reduction of the glucose to sucrose ratio a comparison with the corresponding normal juice shows that this juice has been improved by the process of sulphuring. The improvement has not, however, been as great as would have been supposed, for the purity coefficient does not show an increase.

According to the different ratios of the sulphured juice, 100 parts of the normal juice would, after sulphuring, be represented by:

	Parts.
Total solids	16.09
Sucrose	12.46
Glucose	1.71
Solids not sugar	1.92

Showing that by sulphuring .05 parts of glucose or other substances, reducing the copper solution, were either removed or rendered inert, and that the solids not sugar were increased by .25 parts.

If all these had remained in solution the total quantity of solids on hand would be 16.19 parts. The above table, however, shows that only 16.09 parts remained in solution in the sulphured juice. This shows that .10 parts, or 5.99 per cent of the original solids not sugar, have been removed either by sulphurous acid alone or by its combined action with the lime used at the strainer just before sulphuring.

Although fairly good, these results can not be considered up to the standard of best work. Besides reducing the glucose to sucrose ratio, the purity coefficient should have been raised by the process of sulphuring. By referring to

the "crop report" of 1888 it will be seen, (although it may have been accidental,) that on Belle Alliance, by sulphuring, the ratio of glucose to sucrose was diminished by 2.88 per cent, and the purity coefficient increased by 2.66 per cent.

Applying these figures to the sulphuring results of Evan Hall for 1889, it is found that after sulphuring, 100 parts of the normal juice should have been as follows:

	Parts.
Total solids	15.46
Sucrose	12.40
Glucose	1.71
Solids not sugar	1.20
	Per cent.
Ratio of glucose to sucrose	13.72
Purity coefficient	80.57

These figures show that a sufficient quantity of substances, reducing Fehling's solution, had been removed, but that to be up to the standard the solids not sugar should have been reduced by 22.75 per cent of themselves, instead of 5.09 per cent as above. It accordingly follows that the sulphuring results of Evan Hall are 73.67 per cent inferior to what they should have been. Compared with either the normal juice or the sulphured, it will be seen that after clarification the Evan Hall juices are positively less pure than they were before any attempt was made to remove the impurities which they contained.

Unless the sugar inverted during clarification is equal to 95 per cent of the albuminoids and other substances removed by lime, the purity coefficient of a juice should be invariably increased.

As implied by the term itself the practical gauge of the excellence of clarification is the rate of increase of the purity coefficient and the rate of decrease of the ratio of glucose to sucrose. If, after treatment with lime and sulphur, the purity coefficient, is either to remain stationary or be decreased, it is better and more economical not to have recourse to these agents. Without their use heat alone would produce the desired result by the coagulation of the albuminoids, and the original quantity of sucrose in the juice remaining the same, the purity coefficient would thereby be correspondingly increased.

Returning to the table of the composition of the different juices, it will be seen that compared with the sulphured juice the glucose to sucrose ratio of the clarified juice has been increased. It will also be seen that the purity coefficient has been but slightly increased. According to these actual ratios, in terms of the original 100 parts of normal juice, the Evan Hall sulphured juice, after liming and making due allowance for the noted inversion, would be represented by the following:

	Parts.
Total solids	16.02
Sucrose	12.45
Glucose	1.72
Solids not sugar	1.85

These figures show an inversion of .09 per cent of the original sucrose which is an increase of .59 per cent of the glucose, contained in the original normal juice after sulphuring. On the same basis of comparison it will be seen that both the total solids and the sugar have been reduced by .07 parts, showing that the addition of lime had caused the removal of 3.65 per cent of the solids, not sugar, remaining in the sulphured juice.

This is by no means to be interpreted as evidence of good work, as will be shown presently.

Returning to the results obtained on Belle Alliance during 1888, it is seen that compared with the corresponding sulphured juice, the clarified juice shows a 2.30 per cent decrease in the glucose to sucrose ratio and an .87 per cent increase of purity coefficient. By applying these figures to the corrected statement of what the Evan Hall sulphured juice should have been, it is found that after liming, 100 parts of the normal juice should have been represented by:

	Parts.
Total solids	15.33
Sucrose	12.46
Glucose	1.67
Solids not sugar	1.20
	Per cent.
Ratio of glucose to sucrose	13.40
Purity coefficient	81.27

This demonstrates that in point of view of the reduction of the glucose or other substances reducing the copper liquor, the entire process of clarification of Evan Hall for the past season was 44.44 per cent inferior to what it should have been. From the point of view of the removal of solids not sugar it follows that these should have been reduced by 28.14 per cent. According to the actual composition of the clarified juice (as given above) the original 100 parts of normal juice are found to contain .65 more parts of solids not sugar than they should after liming, and shows that in this respect the clarification is 54.17 per cent inferior to what it should have been.

On the basis of the total solids minus the sucrose contained in the normal juice, the last table given shows that the clarified juice should have contained but 2.87 parts of total impurities, instead of 3.57. This demonstrates that the entire process of clarification was 24.39 per cent inferior to the standard of good work.

EVAPORATION TO SYRUP.

In the following table is given the average composition of the season's syrups as per the different tests made. The samples for analysis were taken after settling, and just before taking the syrup into the vacuum pan for evaporation into masse cuite:

Specific gravity	1.241
Degrees Baumé	28
	Per cent.
Total solids	51.46
Water	48.54
Sucrose	40.12
Glucose	5.53
Solids not sugar	5.81
Ratio of glucose to sucrose	13.78
Purity coefficient	77.96

Compared with the actual analysis of the clarified juice it will be seen that during evaporation the purity coefficient has been slightly increased, and that the glucose to sucrose ratio has been slightly decreased. Owing to this decreased glucose to sucrose ratio it appears that no inversion took place during evaporation, and it consequently follows that the syrup in terms of the original 100 parts of normal juice contains the 12.45 parts of sucrose found to remain after clarification.

The purity coefficient of the syrup being 77.96 per cent, it also follows that on the same basis of comparison the total solids are represented by 15.97 parts.

From the above glucose to sucrose ratio, the glucose remaining in the original juice after evaporation into syrup would be represented by

1.7156 parts, which are practically 1.72 parts, or the quantity found to be present in the juice after clarification. This shows that no inversion can be traced in the work of the double effect.

Deducting the sum of the glucose and sucrose from the above 15.97 parts of total solids, the solids not sugar are found to be equal to 1.80 parts. This shows that during evaporation .05 parts or 2.78 per cent of the solids not sugar remaining in the clarified juice were removed or precipitated.

Had the clarification been as efficient as it was on Belle Alliance in 1888, it follows from the above that under the same evaporating conditions and for the same degree of density, the average composition of the Evan Hall syrups would have been:

	Per cent.
Total solids	51 46
Sucrose	41.94
Glucose	5.62
Solids not sugar	3.90
Ratio of glucose to sucrose	13.40
Purity coefficient	81.50

Had the syrups been as pure as this the result in dry sugar would undoubtedly have been better than it actually was.

FIRST MASSE CUITES.

The average composition of these is as follows:

Specific gravity	1.470
Per cent solids	87.93
Per cent sucrose	71.61
Per cent water	12.07
Per cent glucose	9.87
Per cent solids not sugar	6.45
Ratio of glucose to sucrose	13.78
Purity coefficient	81.43

Compared with the average composition of the syrup the above shows that no inversion can be detected during the process of evaporation to first masse cuite.

It is also to be noticed that owing to a separation of solids not sugar, during the evaporation, the purity coefficient has been very much increased.

In terms of the original 100 parts of normal juice the above masse cuite would be represented by the following proportional parts:

Total solids	15.29
Sucrose	12.45
Glucose	1.72
Solids not sugar	1.12

When compared with the corresponding syrup in the same terms these figures show that during evaporation .68 parts or 37.78 per cent of the solids not sugar held in solution in the syrup were precipitated during evaporation to masse cuite.

COMMERCIAL MOLASSES.

The average composition of this product is as follows:

Specific gravity	1.419
Degree Baumé	43.30
Per cent total solids	80 57
Per cent water	19.43
Per cent sucrose	26.68
Per cent glucose	22.75
Per cent solids not sugar	31.14
Ratio of glucoce to sucrose	85.27
Purity coefficient	33.11

In order to detect any inversion during the handling of the lower products before reaching the final molasess, it is necessary to know how much glucose was removed by the impure commercial sugar. As this sugar was not tested for glucose this can not be estimated with any degree of accuracy, as is shown by the following: By actual weight, it is found that the commercial masse cuite of the crop of 1889 amounted to 4,990,022 pounds, which, according to the analysis of the sugar and molasses, contained 72.92 per cent, or 3,638,682 pounds of sucrose. If no losses of any kind had taken place during the latter processes, the commercial masse cuite should contain the same quantity of sucrose which was found in the first masse cuite.

One hundred pounds of first masse cuite were found, according to analysis, to contain 71.61 pounds of sucrose. Since the sucrose of the commercial masse cuite is 72.92 per cent of the whole, it follows that the commercial masse cuite is represented by 98.20 per cent of the first.

The dry sugar in this commercial masse cuite is represented by 66.49 per cent, of which 96.23 per cent is sucrose. It therefore follows that 87.73 per cent of the sucrose in the first masse cuite was removed by granulation. Applying this figure to the first masse cuite in terms of the original 100 parts of normal juice, it is found that the sucrose accounted for in the dry sugar is equal to 10.92 parts, leaving 1.52, or 12.27 per cent, to be accounted for in the molasses.

The proportion of glucose in the first masse cuite in terms of the original juice is 1.72 parts, hence it follows that theoretically the commercial molasses should have a 113.16 per cent ratio of glucose to sucrose. According to the actual analysis, the molasses is found to have only an 85.27 per cent ratio, and since the proportion of glucose removed with the dry sugar is unknown, this difference can not be properly apportioned. When less care was had in the handling of the different products, this inversion could be approximated, for even without making any allowance for the glucose removed by granulation the excess of the actual glucose to sucrose ratio of the molasses over the theoretical was sufficient to allow for an approximation of the sucrose inverted. Although these conclusions are by no means final, and the results on which they are based probably due more to accident than design, they nevertheless tend to show that the more careful manipulation of the different products resulted in a decreased inversion when compared with that noted in previous reports.

MECHANICAL LOSSES.

Estimating the woody fiber contained in the 22,873 tons of cane ground on the 10 per cent basis, the total number of pounds of sucrose delivered at the sugar house were 5,028,000 pounds.

The 77.19 per cent of normal juice extracted from the cane contained, according to its analysis, 4,400,090 pounds of sucrose, showing that 627,910 pounds or 12.48 per cent of the total sucrose accounted for in the cane remained in the bagasse.

According to analysis 72.56 per cent of the sucrose accounted for in the mill juice is found in the commercial sugar, and 10.14 per cent in the commercial molasses.

This shows a total loss of manufacture of 17.30. If from this quantity, .90 per cent, the only proportion of loss by inversion that can be detected, be subtracted, the mechanical losses

are found to be 16.40 per cent of the sucrose accounted for in the mill juice.

This loss is nearly two and a half times as large as the total losses of 1888, and is all the more surprising because all outlets and wash-out valves were under lock and key.

A certain quantity of soft filter cake was made, but not enough to justify the assumption that this was the outlet. As all the sucrose found in the syrup can be accounted for in the commercial sugar and molasses, leaving a reasonable difference to account for the losses during the latter processes, it follows that in point of view of the commercial masse cuite the work of the house was sufficiently economical. Since, as stated, the great loss detected can not be traced either to the waste during the handling of the final products or in the filter cake, which, on the whole, was a greal deal better than that of previous years, it follows that the main loss must have been due to the boiling over of the double effect.

PART III.

Belle Alliance.

FIELD AND SUGAR-HOUSE RESULTS.

The field results for the crop of 1889 are as follows.

Average tonnage per acre plant cane	19.15
Average tonnage per acre stubble	18.25
Average tonnage per acre plant and stubble	18.80

Compared with 1888, the plant cane results are found to be 4.65 per cent inferior and the stubble 61.19 per cent better. Combining the above for equal areas of plant and stubble the general field results of the crop of 1889 are found to exceed those of 1888 by 19.26 per cent.

By taking the average result of the different kinds of cane for the past fourteen years, for 1889, the results in plant cane are found to be 19.26 per cent below the average, and those of the stubble 22.73 better. For equal areas the combined result of plant and stubble is found to be 3.11 per cent inferior to an average crop.

RUNNING TIME.

The only loss of time that can be detected is a 2.14 per cent, or 25½ hours, for the whole season. Twelve hours of this time was caused by the breaking and replacing of a turn plate, and the greater part of the remaining 13½ was mainly due to blocking the boiling end of the house.

This is a remarkably good record, and is in point of fact the best that has ever come under the notice of the writer.

MILLING.

Notwithstanding the lower percentage of extraction, the milling results of Belle Alliance are considered superior to any that have yet been seen. In this case the lower extraction can be accounted for by thickness of the feed carried.

If instead of grinding at the rate of .00253 tons per square foot of roller surface per hour, only .00226 tons had been ground, it is more than probable that the average percentage of juice extracted would have been as good as that of Evan Hall.

In addition to the above the greater hardness of the cane ground is also believed to have had its effect, notwithstanding the slightly increased rate of saturation over that which was carried on at Evan Hall, viz.: 15.94 per cent of the weight of the cane at Belle Alliance against 15.73 per cent at Evan Hall.

In conclusion, Belle Alliance can only be complimented for its want of lost time and the general excellence of its mill work.

CLARIFICATION.

The average composition of the different juices is as follows:

	Normal.	*Sulph'd.*	*Clarified.*
Specific gravity	1.066	1.055	1.060
Degree Baumé	8.90	7.50	8.10
Per cent total solids	16.17	13.65	14.62
Per cent water	83.63	86.35	85.83
Per cent sucrose	12.94	10.96	11.79
Per cent glucose	1.96	1.70	1.84
Per cent solids not sugar	1.27	.99	.99
Per cent ratio of glucose to sucrose	15.14	15.52	15.61
Purity coefficient	80.02	80.29	80.64

In terms of 100 parts of normal juice, the sulphured and clarified juices, are represented by the following proportional parts:

	Sulph'd.	*Clarified.*
Total solids	16.05	15.97
Sucrose	12.89	12.88
Glucose	2.00	2.01
Solids not sugar	1.19	1.08

The above shows that by sulphuring .38 per cent of the sucrose in the normal juice was inverted. The detection of this inversion is a disappointment, for it would have been supposed that Mr. Riley's excellent sulphur-fume washer and cooler would have prevented any undue absorption of sulphuric acid. Although the testimony appears to be to the contrary, the writer nevertheless believes that Mr. Riley's cooler and washer is as effective a machine as can be gotten up for the purpose. It has already been noticed that with inferior cooling arrangements no inversion could be detected at Evan Hall during the process of sulphuring.

Since up to this point the only difference which existed between the work of the two places was the non-use of milk of lime before sulphur at B. A. it appears that to this cause alone is the above inversion to be attributed.

With regard to the removal of solids not sugar, it is found that by sulphuring, these substances were reduced by 6.30 per cent of themselves.

The above table also shows that during the process of liming and removal of scums a further inversion of .08 per cent of the original sucrose occurred. It is also seen that the solids not sugar were further reduced by 8.66 per cent of what they were in the original juice.

Compared with the results of clarification for 1888, and calculating as was done in the case of Evan Hall, the results of clarification for the past season are found to be 13.80 per cent inferior to what they should have been.

EVAPORATION TO SYRUP.

The average syrup composition for the season is as follows:

Specific Gravity	1.246
Degree Baumé	28.40
Per cent total solids	52.47
Per cent water	47.53
Per cent sucrose	41.11
Per cent glucose	6.16
Per cent solids not sugar	5.20
Per cent ratio of glucose to sucrose	14.98
Purity coefficient	78.35

Compared with the corresponding clarified juice it is found that during evaporation and settling 4 per cent of the substances reducing the copper liquor were removed. It also appears as if these substances were probably not entirely removed in the precipitate at the bottom of the tanks, that some of them were not even precipitated, but simply changed in composition, so that they no longer affected the copper liquor. By forming these combinations and remaining in solution these substances would naturally increase the quantity of solids not sugar. The consequence of this would be the non-increase, or as in the present instance, the reduction of the purity coefficient to a point below that of the original normal juice.

For the present the causes which produced the above peculiar phenomenon are not apparent. It is, however, very important to carefully watch for the same thing in the future, in order to discover, if possible, what are the deleterious influences at work in cases of this kind.

With all the general conditions of work the same as at Evan Hall, the syrups were found to be of greater purity than the corresponding clarified juice.

By applying the same ratio of increase in the purity coefficient Belle Alliance syrups for the past season should have had an 81.12 per cent purity coefficient, instead of 78.35 as it actually was. If this had been the case there is no doubt that the yield of dry sugar from this syrup would have been even greater than it actually was.

FIRST MASSE CUITE.

The average composition of this product is as per the following table:

Specific gravity	1.466
Per cent total solids	87.34
Per cent water	12.66
Per cent sucrose	72.99
Per cent glucose	11.77
Per cent solids not sugar	2.58
Per cent ratio of glucose to sucrose	16.12
Purity coefficient	83.57

In terms of 100 parts of the normal juice the above masse cuite is represented by the following proportional parts:

Total solids	15.27
Sucrose	12.76
Glucose	2.06
Solids not sugar	0.45

Showing that during the process of evaporation from syrup to first masse cuite .93 per cent of the original sucrose in the mill juice was inverted.

In reporting on the crop of 1888 special attention was called to a .95 per cent inversion at the same stage of the process. At that time some doubt was entertained as to the accuracy of the statement, and the fact of finding so nearly the same loss for another year tends to prove the accuracy of the former statement. As was then suggested the cause of this inversion is believed to be a want of proper circulation in the vacuum pan. During the past season the Evan Hall crop was boiled in a low pressure pan, and the fact of not having been able to detect any inversion at this stage of the process justifies the hypothesis that Belle Alliance's inversion was the result of imperfect circulation in the boiling mass.

COMMERCIAL MOLASSES.

The average composition of this product is as follows:

Specific gravity	1.417
Degree Baumé	42.30
Per cent total solids	80.29
Per cent water	19.71
Per cent sucrose	24.25
Per cent glucose	30.67
Per cent solids not sugar	25.37
Per cent ratio of glucose to sucrose	126.47
Purity coefficient	30.20

In the commercial sugar 80.96 per cent of the sucrose in the first masse cuite (in terms of the normal juice) was extracted.

Accordingly the theoretical glucose to sucrose ratio of the molasses is 84.77 per cent.

Compared with the above actual ratio the inversion during the latter part of the process is found to be approximately .27 per cent of the sucrose in the mill juice.

In the case of Evan Hall no inversion could be traced at this stage of the process; hence it follows that the want of proper circulation in the vacuum pan at Belle Alliance has caused a total inversion of 1.20 per cent of the sucrose originally contained in the mill juice.

SUCROSE ACCOUNTED FOR.

In the commercial sugar 79.83 per cent of the sucrose in the normal juice at the time of extraction is accounted for.

In the commercial molasses made an additional 7.06 per cent is found; hence in the commercial masse cuite 86.89 per cent of the sucrose extracted by the mill is accounted for.

MECHANICAL LOSSES.

Assuming that the cane contained 10 per cent of woody fiber, and according to the percentage of juice extracted, the loss of sucrose in the bagasse is found to have been 15.60 per cent of that which was originally contained in the cane.

Compared with the result of extraction for 1888, this loss is found to have been reduced by 18 per cent of itself.

This reduction is entirely due to the high degree of saturation carried on during the past season.

It has already been seen that in the commercial masse cuite 86.89 per cent of the sucrose in the mill juice has been accounted for. The total losses of manufacture, therefore, amount to 13.11 per cent of the same quantity.

If, from this, the 1.66 per cent total loss by inversion be subtracted, the loss by wastage, etc., is found to have been 11.45 per cent.

This is an enormous loss, being nearly two and three-quarter times as great as it was in 1888.

As at Evan Hall this loss results mainly from the boiling over of the double effect. A close study of the conditions of work between syrup and final products shows the loss to have been but very little more than the sucrose inverted between these stages of the process. On the other hand, however, by calculating the number of pounds of sucrose in the mill juice and

syrup, a very large loss is found and can not be attributed to the loss in filter cake. During the past season this by-product was unusually good, and contained but very little sugar. As all the outlets were carefully watched and so closed that practically nothing could be washed out of the sugar house, it follows that the above extraordinary loss must have resulted from the boiling over of the double effects.

FUEL CONSUMED.

The fuel consumed is as follows:

	Barrels.
Actual coal at sugar house and bayou pump	13,121
Six and seven-tenths cords wood reduced to coal	27
Four thousand seven hundred and eighty-three tons of bagasse reduced to coal	13,829
Total	26,977

The above fuel, when divided by the total number of tons of cane ground, gives a proportion of 1.35 barrels per ton.

According to the data for 1888, 100 pounds of cane are found to have yielded 58.03 pounds of water.

Including the water of saturation, 100 pounds of cane in 1889 yielded 80.66 pounds of water.

Assuming the wash waters to have been proportionately the same for both years, under the same conditions of work in 1889, it would have required 38.83 per cent more fuel to manufacture one ton of cane into sugar and molasses than it did in 1888.

According to the above, without multiple effect evaporation to manufacture one ton of cane would have required 2.36 barrels of coal. It has been seen that the actual consumption was 1.35 barrels. It therefore follows the double effect saved about 42.80 per cent of fuel

PART IV.

Souvenir Plantation.

FIELD RESULTS.

The average tonnage per acre for the crop of 1889 is as follows:

Plant cane	13.52
Stubble	17.05
Average for P. and S. (for equal areas)	15.29
General average	16 21

Compared with the results obtained in 1888, plant cane crop is found to be 44.91 per cent short and the stubble 9.74 per cent short. The average plant and stubble crop for equal areas is 29.60 per cent short.

RUNNING TIME.

Allowing a twenty-four hours stop for each Sunday, the time elapsed from the day on which the mill was started to the day on which it was stopped, there are thirty working days.

By throwing out of count all watches on which the mill did not run, the running time of the mill is twenty-seven days, showing that owing to an insufficiency of cane to run all night, etc., three whole days were lost.

The average running time per day is $21\frac{13}{60}$ hours. When compared with the standard of good work with due allowance for sufficient stops for washing out, etc., viz., $23\frac{25}{60}$ hours per day, it is found that Souvenir has sustained a further loss of 7.93 per cent of the running time.

Compared with Evan Hall on the cane ground per square foot of roller surface per hour, 27 per cent loss of time is found. At .00226 tons per square foot per hour, the 6,483 tons of cane ground would have required only eighteen and one-quarter days, after making all necessary allowance for stops, etc.

It, therefore, follows that on a crop of thirty days duration, eleven and three-quarter days, or 39.17 per cent of the time, was unnecessarily lost. This is an important item and should in the future be closely watched.

MILLING.

The percentage of juice extracted is considered very good, viz., 76.32 per cent. This, however, is considered to be more the result of carrying a thin feed than of extra good milling conditions.

Compared with 1888 the extraction is found to be nearly 11 per cent better. On the other hand, the feed carried was 10 per cent thinner; hence the conclusion that the increased rate of extraction is more the result of thin feeds than extra milling conditions.

CLARIFICATION.

The average composition of the different juices is as per the following table:

	Mill.	*Sulphured.*	*Clarified.*
Specific gravity	1.063	1.063	1.066
Degree Baumé	8.50	8.50	8.80
Per cent total solids	15.43	15.54	16
Per cent water	84.57	84.46	84
Per cent sucrose	12.68	12.89	13.23
Per cent glucose	1.58	1.57	1.61
Per cent solids not sugar	1.19	1.07	1.14
Per cent ratio of glu. to sucrose.	12.83	12.18	12.17
Purity coefficient	81.93	82.87	82.68

In terms of 100 parts of normal juice the sulphured and clarified juices are represented by the following proportional parts:

	Sulphured.	*Clarified.*
Total solids	15.30	15.33
Sucrose	12.68	12.68
Glucose	1.54	1.54
Solids not sugar	1.08	1.11

These figures show that owing to the use of milk of lime the sulphured juice contains 2.53 per cent less glucose than before. It will also be noticed that no inversion occurred during clarification proper. The above figures also show that after liming the juice contained more solids not sugar than it did after sulphuring. This is evidence that the clarification was not as effective as it should have been, for the solids not sugar should have been reduced instead of increased.

Compared with the clarification results of Belle Alliance for 1888, these figures show that there was a sufficient reduction in the glucose, but that the clarification is 2.50 per cent interior to what it should have been with regard of the removal of the solids not sugar.

EVAPORATION TO SYRUP.

The average composition of the season's syrup is as follows:

Specific gravity	1.258
Degree Baumé	29.10
Per cent total solids	53.88
Per cent water	46.12
Per cent sucrose	42.52
Per cent glucose	6.72
Per cent solids not sugar	4.67
Per cent ratio of glucose to sucrose	15.81
Purity coefficient	78.92

In terms of 100 parts of normal juice the above is represented by:

Total solids	15.59
Sucrose	12.30
Glucose	1.94
Solids not sugar	1.35

showing that 3 per cent of the original sucrose contained in the mill juice was inverted during the process of evaporation and settling. By the above it is also seen that during evaporation the juices were not sufficiently brushed, for part of the impurities held in suspension in the clarified juice must have reëntered into solution, since the syrup actually contained more solids not sugar than did the clarified juice.

To both these causes is to be attributed the very much decreased purity coefficient. The constantly decreasing purity coefficient, unless accounted for by inversion, can only be attributed to imperfect clarification, and especially to the want of sufficient care on the part of those to whose care this delicate operation is entrusted.

FIRST MASSE CUITES.

By analysis these were found to have the following composition:

Specific gravity	1.487
Per cent total solids	90.37
Per cent water	9.03
Per cent sucrose	73.61
Per cent glucose	11.26
Per cent solids not sugar	5.58
Per cent ratio of glucose to sucrose	15.30
Purity coefficient	81.58

Compared with the corresponding syrup and in terms of the normal mill juice, the above shows a further inversion of .59 per cent of the sucrose originally contained therein.

SUCROSE ACCOUNTED FOR.

In the commercial sugar 80.28 per cent of the sucrose originally in the mill juice is accounted for, and 9.62 per cent of the same quantity in the commercial molasses.

According to what precedes the theoretical ratio of glucose to sucrose of the commercial molasses should be 86.70.

The actual composition of said molasses is:

Specific gravity	1.404
Degree Baumé	42.20
Per cent total solids	78.27
Per cent water	21.73
Per cent sucrose	30.03
Per cent glucose	31.65
Per cent solids not sugar	16.59
Per cent atio of glucose to sucrose	105.39
Purity coefficient	38.37

As the quantity of glucose removed by the commercial sugar is unknown, it is impossible to accurately estimate the inversion which took place in boiling the lower products.

From the above glucose to sucrose ratios it can, however, be approximated. This approximation is represented by 1.46 per cent of the sucrose originally in the mill juice.

It thus appears that the total sucrose inverted in the Souvenir sugar house during the manufacturing season of 1889 is 5.05 per cent of the total sucrose extracted by the mill. During the latter part of the season it was discovered that after boiling out with acid the evaporators were never washed with water, and that very often clarified juice was run into the evaporators before they had had time to become emptied of their contents.

It is mainly to this introduction of acid, (the result of gross ignorance or carelessness,) that the large percentage of inversion noted is to be attributed. Another and not to be overlooked cause of inversion is the putting of the hot syrup in tanks and allowing them to cool. Multiple effect evaporation is a thing that commends itself, both from the point of view of economy in fuel and preventative against inversion.

If multiple effect evaporation is not to be resorted to, then proper and suitable arrangements ought to be made to cool the syrups down to 130 or 140 deg. Fahr. before they are put in bulk to settle their impurities. It cooled they will necessarily require longer settling for a given density. The inconvenience of longer settling can, however, be remedied by a lighter degree of density in the syrup.

Referring to the crop data for 1888, when the general conditions were more favorable to inversion, owing to the use of a high pressure vacuum pan and the non-use of milk of lime at the mills, the total inversion is found to have been 2.08 per cent of the sucrose in the mill juice. If, notwithstanding the improved conditions, it be assumed that the inversion for 1889 is equal to that for 1888, the careless way in which acids were used in cleansing the coils of the evaporating apparatus is found to have caused the inversion of at least 2.97 per cent of the sucrose in the mill juice.

MECHANICAL LOSSES.

On the 10 per cent basis for woody fiber the loss of sucrose in the bagasse is found to have been 15.16 per cent of the sucrose stored up in the cane.

Compared with 1888, it is found that owing to the increased extraction the above loss has been decreased by 35.35 per cent of itself.

It has been seen that in the commercial masse cuite 89.90 per cent of the sucrose in the mill juice is accounted for. The total losses are, therefore, 10.10 per cent of the same standard.

If from this quantity the total 5.05 per cent inversion be subtracted the losses by washing out tanks, waste, and in filter press cake are of only 5.05 per cent, against 11.89 per cent in 1888.

This shows that by the introduction of filter presses the mechanical losses were reduced by 57.53 per cent of themselves.

FUEL CONSUMED.

	Barrel.
Actual coal	9,317
Fifteen cords wood (estimated as coal)	60
1,567 tons bagasse, (estimated as coal)	4,280
Total	13,657

Per ton of cane ground the proportion of fuel is 2.25 barrels coal. Compared with 1888 there

is found to be an excess of 9.33 per cent. This excess is, however, only apparent, as the following will show:

According to the percentage of juice extracted and the percentage of water in same, 100 pounds of cane in 1888 yielded 58.41 pounds of water, against 64.54 pounds, or an excess of 11.01 per cent, in 1889. Assuming the quantity of water added in washing sugars, reducing molasses, etc., to have been proportionately the same for both years, it follows from the above that under the same conditions to manufacture one ton of cane into sugar required 11.01 per cent more fuel in 1889 than it did in 1888.

It has been seen that the 1889 excess is only 9.33 per cent; hence the conclusion that the low pressure vacuum pan saved about 1.68 per cent of fuel.

PART V.

New Hope and Ascension Plantations.

FIELD RESULTS.

The plant and stubble not having been kept separate, comparisons of the relative excellence of these crops are thereby rendered impossible.

The average tonnage per acre for both places is as follows:

New Hope	19.99
Ascension	17.75
New Hope and Ascension	18.87

showing that New Hope's field results have exceeded those of Ascension by 12.62 per cent.

This difference is believed to be due to the greater area of stiff land on Ascension. From present lights a greater conformity of result might be obtained by the general use of more highly nitrogenized manures on Ascension.

RUNNING TIME.

By allowing a 24-hour stop on each Sunday, the time which elapsed during the past grinding season was 40 days. By counting only the watches on which the mill ran, the running time is found to have been 39¼ days.

The average number of hours during which the mill ran each day is $21\frac{40}{60}$. Compared with the standard of $23\frac{25}{60}$ the lost time is found to have been 7.48 per cent. On the basis of the quantity of cane ground per square foot of roller surface per hour the loss of time is found to have been 15.04 per cent, when compared with the work accomplished at Evan Hall.

From what precedes it follows that with all due allowance for necessary stops, etc., the 16,608 tons of cane ground should have been run through in 28¾ days.

This shows that 11¼ days were lost by what can only be termed imperfect management.

In the future a great deal of attention should be given to this matter, as lost time is one of the principal elements which swell the grinding expenses.

MILLING.

The average percentage of juice extracted from the cane was 71.54 per cent. For reasons already given in another section of this report this extraction is considered very inferior.

From the average tonnage per acre of the cane, and the relatively thin feed carried, the above extraction is considered to be about 10 per cent inferior to what it should have been.

This shortage is believed to be due to the want of sufficient pressure on the mills.

Whilst the mills are known to be a little weak in construction, the same cane, under ordinarily good milling conditions, should have yielded between 76 and 77 per cent of its weight in juice, and in consequence the results in sugar and molasses per ton of cane would have been about 10 per cent larger than they actually were.

CLARIFICATION.

The average composition of the different juices is as follows:

	Mill	*Sulphured*	*Clarified*
Specific gravity	1.066	1.065	1.069
Degree Baumé	9.00	8.80	9.30
Per cent solids	16.27	15.89	16.84
Per cent water	83.73	84.11	83.16
Per cent sucrose	13.23	12.59	13.61
Per cent glucose	1.69	1.72	1.88
Per cent solids not sugar	1.35	1.58	1.35
Per cent ratio of glucose to sucrose	12.77	13.66	13.81
Purity coefficient	81.36	79.23	80.81

In terms of 100 parts of the normal juice the sulphured and clarified juices are represented by the following table of proportional parts:

	Sulphured	*Clarified*
Total solids	16.56	16.22
Sucrose	13.12	13.11
Glucose	1.79	1.81
Solids not sugar	1.65	1.30

The above shows that during the process of sulphuring .81 per cent of the original sucrose was inverted. During clarification proper a further inversion of .07 per cent of the same quantity is found.

This .88 per cent inversion is in all probability the result of the following causes, viz.: 1. The non-use of milk of lime at the mill and before sulphuring. 2. A probable excessive sulphurization. 3. The use of settling tanks for the sulphured juice. These tanks should by all means be removed and the juice should always be sent to the clarifiers just as it comes out of the sulphur machines and without settling.

According to the standard of good work already used in previous sections the above juices should have had the following composition:

	Sulphured	*Clarified*
Per cent of total solids	15.84	15.70
Per cent of sucrose	13.23	13.23
Per cent of glucose	1.64	1.61
Per cent of solids not sugar	0.97	0.86
Per cent ratio of glucose to sucrose	12.40	12.11
Purity coefficient	83.52	84.25

These figures show that from the point of view of the removal of glucose and solids not

sugar. the results of sulphuring were 31.80 per cent, and those of the entire process of clarification 25.91 per cent inferior to what they should have been.

This should not be, for the arrangements at New Hope are such that well clarified juices should always result from the ordinary handling of the juices, providing that both sulphuring and clarification be carried to the proper point.

EVAPORATION TO SYRUP.

The average composition of the syrup is as follows:

Specific gravity	1.218
Degree Baumé	25.80
Per cent total solids	47.39
Per cent water	52.01
Per cent sucrose	37.77
Per cent glucose	5.49
Per cent solids not sugar	4.14
Per cent ratio of glucose to sucrose	14.53
Purity coefficient	79.70

The above analysis indicates a .60 per cent inversion of the sucrose originally in the mill juice.

Both at Evan Hall and Belle Alliance it has been seen that no inversion could be detected in the work of the double effects. With its triple effect of the same construction it is believed that the same should have been the case at New Hope.

That the above rate of .60 per cent of inversion is not even greater is believed to be entirely due to the fact that during part of the season all the syrups were not reheated before being sent to the settling tanks.

In order to determine the quantity of sucrose which is destroyed by the reprehensible practice of reheating the syrup after it leaves the triple effect, a number of special tests were made of the syrup just before heating and just before being taken up into the vacuum pan.

The average of these is as follows:

	Before.	*After.*
Specific gravity	1.214	1.223
Degree Baumé	25.40	26.20
Per cent total solids	46.61	48.21
Per cent water	53.39	51.79
Per cent sucrose	36.92	37.44
Per cent glucose	5.32	6.16
Per cent solids not sugar	4.37	4.61
Per cent ratio of glucose to sucrose	14.40	16.18
Purity coefficient	79.21	77.66

To increase the glucose to sucrose ratio from 14.40 to 16.18 per cent necessitates the inversion of 1.68 per cent of the sucrose in the syrup as it comes out of the triple effect.

On the other hand,as has already been stated in a previous section, the reheating of syrups has a tendency to increase the purity coefficient.

If suitable arrangements were made to immediately cool the reheated syrup to temperature not exceeding that at which it comes out of the 3rd effect (130 to 140 deg. F.) the practice of reheating is one that can be recommended as being conducive to good results.

On the other hand, however, if the syrup is not to be cooled as prescribed, it can not be too strongly urged that all open pans used for that purpose be relegated to the scrap pile.

EVAPORATION TO FIRST MASSE CUITE.

In the folllowing table is given the average composition of the first masse cuites, viz:

Specific gravity	1.492
Per cent total solids	91.44
Per cent water	8.56
Per cent sucrose	71.80
Per cent glucose	12.05
Per cent solids not sugar	7.60
Per cent ratio of glucose to sucrose	16.78
Purity coefficient	78.41

Compared with the corresponding syrup the above shows that during the process of boilng to first masse cuite 2.42 per cent of the sucrose in the original normal juice was inverted.

The causes of this inversion are believed to have been due to the presence of certain quantities of free sulphuric acid which resulted from improper sulphuring, and principally to the great length of time which was required to boit the different strikes.

It is of the greatest importance that less time should be taken up in the boiling process. That this can be accomplished without changes to the vacuum pan is the belief and conviction of the writer.

The New Hope vacuum pan is of the same cubical capacity as that at Evan Hall and contains over 33 per cent more heating surface than did the Evan Hall pan before it was changed to low pressure. In those days a strike could be very comfortably made in from 6 to 7 hours. During the past season the average time of the New Hope strikes not infrequently reached 12 to 13 hours and sometimes longer. In conclusion, it is to be strongly urged that the boiling be done in a more expeditious manner, for nothing is more favorable to inversion than the submitting of saccharine liquors to long-continued heat, even if this heat be of comparatively low degree.

COMMERCIAL MOLASSES.

In the commercial sugar 82.96 per cent of the sucrose in the first masse cuite is accounted for. Accordingly, if no inversion had taken place during the handling of the lower products, the glucose to sucrose ratio of the molasses should have been 96.82 per cent.

The actual composition of the commercial molasses, as per analysis, is as follows:

Specific gravity	1.427
Degree Baumé	42.70
Per cent total solids	81.75
Per cent water	18.27
Per cent sucrose	25.20
Per cent glucose	29.48
Per cent solids not sugar	27.07
Per cent ratio of glucose to sucrose	116.50
Purity coefficient	30.82

Compared with the above theoretical glucose to sucrose ratio the above figures show that during the manufacture of second sugar and the reboiling of the molasses a further inversion of 1.51 per cent of sucrose in the original mill juice has taken place.

MECHANICAL LOSSES.

On the basis of 10 per cent woody fiber in the cane the loss in the bagasse is found to have been 20.57 per cent of the sucrose stored up in the cane.

In the commercial sugar 79.44 per cent of the sucrose accounted for in the mill juice is found, and in the commercial molasses a further proportion of 9.98 per cent is accounted for.

This shows that in the commercial masse cuite 89.40 per cent of the original sucrose in the mill juice is accounted for.

The total losses of manufacture are conse-

quently 10.58 per cent of the same quantity. If from this the total inversion detected, viz., 5.41 per cent, be subtracted, the mechanical losses are found to have been 5.17 per cent. In this respect the work is thought to have been quite economical, but it is nevertheless believed that with greater care this percentage of loss by waste, washing out of tanks, etc., can be very much reduced.

With regard to the inversion, a great deal of care should be had as to the manner in which sulphur is used in the future, for a considerable part of the inversion noted was no doubt due to this cause alone. When, coupled with this, you add the reheating of the syrup, it becomes almost impossible to estimate to what extent the inversion might not reach.

In the case under notice the sucrose inverted amounts to ten pounds of commercial sugar per ton of cane ground.

PART VI.

Results of Belle Terre, Peytavin, Rodriguez, and Crescent Plantations.

FIELD RESULTS.

Along with the contributions of a few tenants and outsiders all the cane of the above places was ground in the Belle Terre sugar house. The average tonnage per acre of each of the above is as follows:

Belle Terre, plant and stubble	17.70
Peytavin and Dugas, plant and stubble	15.30
Rodriguez, plant and stubble	14.40
Crescent, tenants and outsiders, plant and stubble	15.92

Compared with those of Belle Terre the results of the other places show the following rates of inferiority:

	Per cent.
Crescent, tenants and outsiders	10.06
Peytavin and Dugas	13.62
Rodriguez	18.64

RUNNING TIME.

Exclusive of 24-hour stops on each Sunday the mill is found to have run more or less during 50 days. Counting by watches, on which cane was run through the mill, the running time is found to have been 44½ days, showing that 5½ working days were unnecessarily lost. The main cause of this loss was running out of cane period. Attention has already been called to the fact that in a well-ordered sugar house the average daily stops should not exceed thirty-five minutes. Accordingly, a further 13.11 per cent loss of time is noted. Summarizing, it follows that the 19,102 tons of cane hould have been ground in 38¾ days, instead o 150. This shows a total loss of time amounting to 11½ days, which is 23 per cent of the total time required to take off the crop.

In the future this point should be very closely watched, for continuous and steady running is the most effective way of reducing the cost of manufacture.

MILLING.

Per square foot of roller surface per hour the cane ground is found to have amounted to 00235 tons.

This is considered to be a good rate of speed, and one which, under ordinarily good milling conditions, would produce an average percentage of extraction varying between 76 and 78 per cent.

On the other hand, the actual percentage of juice extracted from the cane is found to have been 73.59 per cent. This is a shortage of about 6 per cent, which is believed to have been due to the breaking of one of the back rollers.

As a matter of course, it is impossible to do good mill work with a crippled back mill.

CLARIFICATION.

The average composition of the different juices is as follows:

	Mill	*Sulphured*	*Clarified*
Specific gravity	1.073	1.069	1.069
Degree Baumé	9 98	9.50	9.40
Per cent total solids	17.68	16.89	16.76
Per cent water	82.32	83.11	83.24
Per cent sucrose	14.27	14.12	14.05
Per cent glucose	1.72	1.71	1.68
Per cent solids not sugar	1.69	1.06	1.03
Per cent ratio of glucose to sucrose	12.05	12.11	11.97
Purity coefficient	80.69	83.60	83.83

In terms of 100 parts of the normal juice the sulphured and clarified juices are represented by the following proportional parts:

	Sulphured	*Clarified*
Total solids	17.04	17.00
Sucrose	14.25	14.25
Glucose	1.73	1.71
Solids not sugar	1.06	1.04

These figures show that notwithstanding a small quantity of milk of lime used before sulphuring in the sulphur juice .14 per cent of the sucrose contained in the normal mill juice is found to have been inverted. In addition to the probable insufficiency of milk of lime the above inversion is believed to have been due to the following causes: First, insufficient washing of the sulphured fumes before saturating the juices with them, and secondly, allowing the juice to stand in bulk before being sent to the clarifiers after sulphuring. Save for the inversion just noted the clarification is considered to have been quite effective, and even better than that of the other places of which we have already spoken.

According to the standard by which the clarification of the other places has been compared the sulphured and clarified juices of Belle Terre should, in terms of 100 parts of normal juice, have had the following composition:

	Sulph'd.	*Clarified.*
Per cent total solids	17.22	87.07
Per cent sucrose	14.27	14.27
Per cent glucose	1.67	1.63
Per cent solids not sugar	1.28	1.17
Per cent ratio of glucose to sucrose	11.70	11.43
Purity coefficient	82.84	83.59

This demonstrates that in point of view of the glucose content the sulphured juice is 4.37 per

cent and the clarified 4.31 per cent inferior to what they should have been.

In point of view of the removal of solids not sugar, the actual results are found to have been superior even to the standard by which we have compared.

In conclusion, all that can be said is that it is to be hoped that in the future the solids not sugar will be removed in as effective a manner.

If to this by greater care and a more judicious use of sulphur the coefficient of inversion be reduced to zero, the clarification at Belle Terre will leave but little room for improvement until experience will have taught us that even these results can be improved upon.

EVAPORATION TO SYRUP

The average composition of the syrup is as follows:

Specific gravity	1.245
Degree Baumé	28.90
Per cent total solids	52.27
Per cent water	47.73
Per cent sucrose	43.98
Per cent glucose	5.33
Per cent solids not sugar	2.96
Per cent ratio of glucose to sucrose	12.12
Purity coefficient	84.14

Compared with the corresponding clarified juice, the above shows that during evaporation .14 per cent of the sucrose originally in the normal juice was inverted. It has been shown that with double-effect evaporation no inversion could be detected at this stage of the process either at Evan Hall or at Belle Alliance. It is accordingly believed that the above .14 per cent is an after result of sulphuric acid which was probably introduced in the juices at the time of sulphuring.

Another cause which may have induced a part of this inversion was the general tendency to keep too much liquor in the double-effect pans. By this practice, not only is the evaporating capacity of the pans somewhat cut down, but there is a greater danger of having a given quantity of saccharine liquor subjected to the heat during too long a time.

EVAPORATION TO FIRST MASSE CUITES.

Complete analyses of this product were not made, but both the glucose and sucrose were determined therein.

The averages for the season are as follows:

Per cent of sucrose	77.17
Per cent of glucose	9.41
Per cent ratio of glucose to sucrose	12.19

Compared with the corresponding syrup, the above shows a further inversion of .07 per cent of the sucrose in the normal juice.

This inversion is thought to have been due to several causes, viz.: Those already mentioned in the paragraph relating to the syrups and to boiling at high pressure in the vacuum pan, instead of low pressure.

Had not the vacuum pan boiled as rapidly as it did, (sometimes boiling a strike in from 2½ to 3 hours,) the above coefficient of inversion would, no doubt, have been greater than .07 per cent.

INVERSION BETWEEN FIRST AND COMMERCIAL MASSE CUITE.

After allowing for the sucrose removed by granulation, the theoretical glucose to sucrose ratio of the commercial molasses is found to be 49.57 per cent. The actual composition of the commercial molasses is as follows:

Specific gravity	1.413
Degree Baumé	42.90
Per cent total solids	79.57
Per cent water	20.43
Per cent sucrose	31.76
Per cent glucose	25.78
Per cent solids not sugar	22.03
Per cent ratio of glucose to sucrose	81.17
Purity coefficient	39.91

When compared with the theoretical glucose to sucrose ratio the above shows that during the manufacture of second sugars and the reboiling of the commercial molasses 4.14 per cent of the sucrose in the normal juice was inverted.

COMMERCIAL MASSE CUITES.

In the commercial sugar, 75.20 per cent of the sucrose extractied in the mill is accounted for. In the commercial molasses, 10.87 per cent of the same quantity is also accounted for. This shows that 86.07 per cent of the sucrose in the mill juice is found in the commercial masse cuite.

MECHANICAL LOSSES.

On the 10 per cent basis for woody fiber, and according to the percentage of juice extracted from the cane, the sucrose lost in the bagasse is found to have been 18.23 per cent of that stored up in the cane.

This loss is enormous, and should be reduced by a more thorough system of saturation between the two mills.

It has already been seen that in the commercial masse cuite 86.07 per cent of the sucrose in the mill juice was recovered. It therefore follows that the total losses of manufacture amounted to 13.93 per cent of the same quantity.

If from this the 4.49 per cent loss by inversion be subtracted the loss by washing out of tanks in the filter cake, etc., is found to have been 9.44 per cent.

As at Evan Hall and Belle Alliance this loss was mainly due to the boiling over of the double effects. Although this evil might not be readily remedied, it would no doubt be advantageous not to carry so much liquor in the pans.

The proportion of the above loss due to filter cake can also be remedied by the following method:

All syrup tank bottoms should be sent back to the clarifiers, and wherever the filter cake shows a tendency to be soft and mushy, lime should be added to the skimmings before being sent to the filter presses.

PART VII.

Palo Alto Plantation.

FIELD RESULTS.

The average tonnage per acre is as follows:

Plant cane	24 45
Stubble cane	22.05
General average plant and stubble cane	23.30

For a year like 1889 these are excellent results.

RUNNING TIME.

Exclusive of 24-hour stops on Sundays the time required to take off the crop was 50 days.

Counting by watches on which the mill ran the running time is found to have been 44½ days. The average running time per day was 20¾ hours. According to the standard $23\frac{25}{60}$ hours per day, the time lost amounts to 2 hours and 40 minutes per day of actual running time. Whilst the mill could be made to grind more cane, it is believed that it would do so at the expense of extraction. By overcrowding it there would also be danger of expensive breakdowns. Accordingly, a feed of .00215 tons per square foot of roller surface per hour is thought to be all that the mill can do with any relative degree of safety.

By grinding at the same rate, viz: .00215 tons per square foot of roller surface per hour, if the mill had been run $23\frac{25}{60}$ hours instead of $20\frac{15}{60}$ hours per day, the 12,903 tons of cane could have been ground in 39½ working days. This shows that in a season of 50 days, 21 per cent or 10½ days were lost.

MILLING.

Considering the size and strength of the mills and gearing this operation was very successfully carried out. The percentage of juice extracted is a great deal better than might have been expected, and is attributable to the softness of the cane and to saturation.

CLARIFICATION.

The average composition of the different juices is as follows:

	Mill.....	*Sulphured.*	*Clarified...*
Specific gravity	1.063	1.063	1.065
Degree Baumé	8.50	8.50	8.80
Per cent total solids	15.40	15.40	15.88
Per cent water	84.60	84.60	84.12
Per cent sucrose	12.37	12.30	12.85
Per cent glucose	1.80	1.80	1.85
Per cent solids not sugar	1.23	1.30	1.10
Per cent ratio of glucose to sugar	14.52	14.03	14.39
Purity coefficient	80 34	79.88	80.92

In terms of 100 parts of normal juice the above sulphured and clarified juices are represented by the following proportional parts.

	Sulphured...	*Clarified...*
Total solids	15.47	15.27
Sucrose	12.36	12.36
Glucose	1.81	1.78
Solids not sugar	1.30	1.13

These figures show that during the process of sulphuring .08 per cent of the sucrose in the mill juice was inverted. This inversion is thought to be attributable to the non-use of milk of lime at the mill, and probably also to allowing some of the sulphured juices to stand in bulk before subjecting them to clarification.

Compared with the mill juice the clarified juice is found to contain 8.13 per cent less solids not sugar than before treatment with sulphur and lime.

According to the standard of clarification used in all previous comparisons the composition of the above juices should be:

	Sulphured...	*Clarified...*
Per cent total solids	15.00	14.87
Per cent sucrose	12 37	12.37
Per cent glucose	1.74	1.70
Per cent solids not sugar	.89	.80
Per cent ratio of glucose to sucrose	14.10	13.78
Purity coefficient	82.48	83.20

These figures show that the sulphured juice contained 4.02 per cent more glucose and 50.62 per cent more solids not sugar than it should have contained.

With regard to the clarified juice a 4.71 per cent excess of glucose and a 41.25 per cent excess of solids not sugar are found.

In point of view of the purity coefficient the sulphured juice is found to be 3.15 per cent and the clarified juice 1.54 per cent inferior to what they should have been.

In order to remedy this the only thing that can be recommended is that the men who have charge of the delicate operation of clarification be impressed with the absolute necessity of being as careful as they can possibly be with the work entrusted to their care.

EVAPORATION TO SYRUP.

The average composition of this product is as follows:

Specific gravity	1.0267
Degree Baumé	30.30
Per cent total solids	56.08
Per cent water	43.92
Per cent sucrose	44.50
Per cent glucose	6.91
Per cent solids not sugar	4.59
Per cent ratio of glucose to sucrose	15.58
Purity coefficient	79.42

In terms of 100 parts of normal juice the above syrup is represented by the following proportional parts:

Total solids	15.42
Sucrose	12.24
Glucose	1.91
Solids not sugar	1.27

These figures show that during the process of evaporation and settling of the syrup .97 per of the sucrose contained in the mill juice was inverted.

In order to determine how much sugar was inverted during the process of evaporation proper a number of special experiments were made.

For these, as soon as an evaporator had been charged with clarified juice, a sample of the contents was analyzed.

As soon as the density had been reduced to the desired point the contents were again analyzed.

The average of eleven of these experiments is given in the following table:

	Clarified juice.	Syrup.
Specific gravity	1.071	1.259
Degree Baumé	9.50	29.60
Per cent total solids	17.14	54.72
Per cent water	82.86	45.28
Per cent sucrose	13.80	44.00
Per cent glucose	1.66	5.50
Per cent solids not sugar	1.68	5.22
Per cent ratio of glucose to sucrose	12.03	12.50
Purity coefficient	80.51	80.41

These figures show that during evaporation .65 per cent of the sucrose contained in the clarified juice was inverted.

By applying these figures to the crop average composition of the clarified juice in terms of 100 parts of the normal juice, it is found that .64 per cent of the sucrose in the mill juice was inverted in the evaporators.

It has already been seen that between the points of clarified juice and syrup just before being taken up in the vacuum pan .97 per cent of the original sucrose was inverted.

The above .64 per cent is nearly two-thirds of this quantity; it therefore follows that the inversion which took place in the settling tanks must have amounted to .33 per cent of the originial sucrose in the mill juice.

In the future it is strongly to be desired that the syrups be not so much reduced in density as they were during the past season. It is claimed by the best authorities on this subject that up to a density of 20 or 22 deg. Baumé (hot) little or no inversion takes place in the open evaporators. Past this point, however, the inversion is very rapid, and in a general way it can be said that the greater the density the more sugar has been inverted. As has already been suggested with regard to other places rapid cooling of syrups is strongly to be advised.

EVAPORATION TO FIRST MASSE CUITE.

According to analysis this product is found to have had the following average composition:

Specific gravity	1.504
Per cent total solids	92.72
Per cent water	7.28
Per cent sucrose	73.33
Per cent glucose	11.79
Per cent solids not sugar	7.60
Per cent ratio of glucose to sucrose	16.09
Purity coefficient	79.09

Compared with the corresponding syrup the above shows that during the time that the syrup remained in the vacuum pan .48 per cent of the sucrose in the mill juice was inverted.

This inversion is mainly due to the work of boiling having been performed in a high-pressure instead of a low-pressure pan.

COMMERCIAL MOLASSES.

In the following table is given the average composition of this product:

Specific gravity	1.417
Degree Baumé	42.30
Per cent total solids	80.12
Per cent water	19.88
Per cent sucrose	26.74
Per cent glucose	30.09
Per cent solids not sugar	23.29
Ratio of glucose to sucrose	112.53
Purity coefficient	33.38

In the commercial sugar 79.72 per cent of the sucrose in the first masse cuite is accounted for.

In this instance the percentage of glucose was determined in the sugars, viz.: 4.83 per cent of the weight of the second and third sugars. When calculated out this glucose is found to be 7.15 per cent of the total glucose found in the first masse cuite. It is accordingly found that, if no inversion had taken place during the boiling of the lower grades of sugar, etc., the commercial molasses would have had a 72.07 per cent glucose to sucrose ratio.

Compared with the actual glucose to sucrose ratio it is found that 3.55 per cent of the sucrose contained in the original mill juice was inverted during the time that the lower products remained in the vacuum pan and hot room. Summarizing what has been said on the subject of inversion, it is found that from various causes 5.08 per cent of the sucrose in the original mill juice was inverted during the process of manufacturing same into commercial sugars and molasses.

MECHANICAL LOSSES.

On the 10 per cent basis for woody fiber the loss of sucrose in bagasse is found to have been 19.67 per cent of the quantity present in the cane at the time of crushing same.

Of the sucrose extracted by the mill 78.50 per cent is found in the commercial sugar and 10.92 per cent in the molasses, showing that the total losses of manufacture are 10.58 per cent of the same quantity.

If, from the above, the 5.08 per cent loss by inversion be subtracted, the loss by waste, imperfect filter cake, washing out of tanks, etc., is found to have been 5.50 per cent.

By greater care and attention in the manner of handling the different products this loss could be very much reduced.

It is very desirable that lime water be used to wash all wooden troughs and other places where juice and syrup come in contact with wood. Unless wooden troughs are kept thoroughly clean, and even a little alkaline, the juices which are absorbed into the pores of the wood in a short time become acid and induce inversion, as is demonstrated by the following data.

After having cleaned and limed a wooden trough which conducted the filtered juices from the filter presses back to the clarifiers, for six successive days the same juice, or as nearly the same as was possible to get at, was tested both before and after passing through the trough. The results of these comparative tests show that the rate of increase of the glucose to sucrose ratio became greater and greater as time went on.

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SUCROSE IN THE MILL JUICE.

	Per cent.
Evan Hall	12 46
Belle Alliance	12.94
Souvenir	12 68
New Hope	13 23
Belle Terre	14 27
Palo Alto	12.37

SUCROSE IN THE DIFFERENT SUGARS.

	Gran	*Soft white.*	*Yellow clarifed.*	*Total first sugars ..*	*Seconds...*	*Thirds ....*	*Total sugars ..*
Evan Hall.....	99.70	99.20	97.24	97 30	92.51	86.90	96 23
Belle Alliance.	.....	99.00	97.80	97.81	90.86	87.00	96.28
Souvenir.....	.....	98.50	97.80	97 82	93.10	89 15	96.76
New Hope.....	.....	98.84	98.41	98.51	95.21	.....	97.16
Belle Terre....	.....	97.82	97.27	97.42	92.53	90.41	95 93
Palo Alto.....	.....	99.24	.....	99.24	89 99	92 30	96.64

RESULTS PER TON AND PER ACRE.

	SUGAR.		MOLASSES.		COMMERCIAL MASSE C'TES.	
	Tons...	*Acres..*	*Tons...*	*Acres..*	*Tons...*	*Acres...*
Evan Hall.....	145.05	3,187	73.11	1,606	218.16	4,793
Belle Alliance...	163	3,065	75.14	1,413	238.14	4,478
Souvenir.....	154.87	2,535	81.21	1,329	236.08	3,864
New Hope.....	154.68	2,918	79.95	1,415	229.63	4,333
Belle Terre.....	164.42	2,617	72.07	1,147	236.49	3,764
Palo Alto	145.26	3,384	72.8	1,696	218 06	5,08

Per cent of the time actually required to take off the crops, which was unnecessarily lost, amounted to:

	Per cent.
On Evan Hall	11.73
On Belle Alliance	....
On Souvenir	39.17
On New Hope	28.13
On Belle Terre	23
On Palo Alto	21

Per cent of the sucrose contained in the cane, sucrose lost in bagasse amounted to per cent of that in the cane:

	Per cent.
On Evan Hall	12.48
On Belle Alliance	15.6
On Souvenir	15.16
On New Hope	20.57
On Belle Terre	18.23
On Palo Alto.	19.67

Losses by inversion per cent of the sucrose contained in the mill juice:

	Per cent.
On Evan Hall.	.90
On Belle Alliance	1.66
On Souvenir	5.05
On New Hope	5.41
On Belle Terre	4.49
On Palo Alto	5 08

The losses of manufacture, other than by inversion, and per cent of the sucrose in the mill juice are:

	Per cent.
On Evan Hall	16.4
On Belle Alliance	11.45
On Souvenir	5.05
On New Hope	5.17
On Belle Terre	9.44
On Palo Alto	5.5

After deducting all losses of manufacture and inversion from the sucrose in the mill juice, the sucrose recorded in the firsts, seconds, and thirds, and the molasses of commerce representing 100 parts, the following proportional division can be made:

	In the first sugar.	*In the second and third sugars.*	*In the molasses.*
On Evan Hall.....	64 42	24.43	11.15
On Belle Alliance...	72 87	16 47	10.66
On Souvenir.....	68 81	17.16	14.03
On New Hope.....	68.39	19 66	11.95
On Belle Terre.....	64.25	22.14	13.51
On Palo Alto.....	63.92	23.87	12.21

With the exception of Palo Alto, where there was too much water used in washing the first sugars, the above figures show that the best results in first sugar boiling were obtained at Belle Alliance.

This is believed to have been entirely the result of stiff boiling.

This shows that, as compared with Belle Alliance, on the other places the operation of making first sugar had the following degrees of interiority:

	Per cent.
Evan Hall	11.60
Souvenir	5.57
New Hope	6.16
Belle Terre	11.83
Palo Alto	12.28

The total sucrose accounted for in all the different grades of sugar is as follows:

	Per cent.
Evan Hall	88.85
Belle Alliance	89.34
Souvenir	85.97
New Hope	88.05
Belle Terre	86.39
Palo Alto	87.79

The shortages in the sucrose accounted for in the total sugars accordingly are—

	Per cent.
For Evan Hall	0.55
For Souvenir	3.78
For New Hope	1.44
For Belle Terre	3.32
For Palo Alto	1 74

On Evan Hall and New Hope the shortage is believed to have been entirely due to want of stiffness in boiling, for owing to the large capacity of the hot rooms the errors in the boiling of the first products were in a measure rectified in the boiling of the second sugars. Had not a certain quantity of third sugars been made at Evan Hall its shortage would undoubtedly have been greater. On Souvenir, Belle Terre, and Palo Alto the shortage in total sugars is principally due to the want of sufficient capacity in the hot rooms. If the percentage of juice extracted on each place had been the same as that on Evan Hall, the various coefficients of loss the same as the lowest noted in the foregoing pages, and the sucrose recovered in the sugars in every instance the same as at Belle Alliance, the yields per ton of cane for each of the places would have been as follows:

	Pounds.
For Evan Hall	169.80
For Belle Alliance	177.80
For Souvenir	173.80
For New Hope	180.38
For Belle Terre	215.52
For Palo Alto	169.36

This proves that with such sugars as were made, the different plantations show the following shortages in their results:

	Per cent.
Evan Hall	14.58
Belle Alliance	8.32
Souvenir	10.09
New Hope	14.25
Belle Terre	23.71
Palo Alto	14.24

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